MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2019/2020

PCG0245 – CELLULAR REPRODUCTION AND GENETICS

(Foundation in Life Sciences)

3 MARCH 2020
9.00 a.m – 11.00 a.m
(2 Hours)

INSTRUCTIONS TO STUDENT

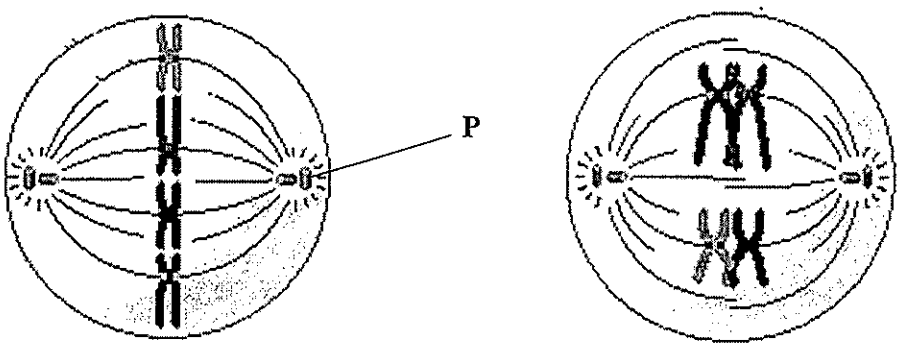
1. This Question paper consists of **11** printed pages excluding the cover page with **5** structured questions.
2. Answer **ALL** questions.
3. Distribution of marks for each section/question is given.

STRUCTURED QUESTIONS [50 MARKS]

Instructions: Answer all questions. Write your answers in the answer booklet.

Question 1 (10 marks)

a. **Figure 1** shows different stages of meiosis in cell **X** and cell **Y**.
   i. Identify the stage of meiosis in cell **X** and cell **Y**. (1 mark)
   ii. Briefly describe two differences of the stages that happen in cell **X** and cell **Y**. (2 marks)
   iii. Explain what will happen to the chromosome behavior during cell division if a type of chemical which can disturb the function of **P** is inserted into the cell. (1 mark)



cell **X** cell **Y**

Figure 1

b. Plant and animal cells carry out mitosis to form two genetically identical cells from one original cell. Give two other reasons why mitosis is important in both plants and animals. (1 mark)

c. Oculocutaneous albinism (OCA) is a type of albinism. It is caused by a recessive mutation in the autosomal gene. A person with OCA has white hair, very pale skin and pink eye colour. Draw a genetic diagram to show the probability of a child having OCA, if both parents are carriers of the gene for OCA. Use the symbols **A** and **a** to represent the alleles for OCA.

(2 marks)

Continued...

d. In tomato, smooth fruit 'S' is dominant over wrinkled fruit 's' and red flowers 'R' are dominant over white flowers 'r'. A test cross between a tomato plant with smooth fruit and red flowers and a plant with wrinkled fruit and white flowers gives the following results:

Smooth fruit, red flower	300
Wrinkled fruit, white flower	300
Smooth fruit, white flower	100
Wrinkled fruit, red flower	100

i. Calculate the recombination frequency in percentage. (1 mark)
ii. If there is another gene controlling the sugar content of tomato (m) located on the same chromosome as s and r, draw the relative positions of genes s,r and m on the chromosome. [Recombination frequency: m & r = 10% ; s & m = 15%] (1 mark)

e. What is the difference between *carcinomas* and *sarcomas*? (1 mark)

Question 2 (10 marks)

a. *Senecio vulgaris* has different types of flowers. The character is controlled by a pair of alleles which has no dominance. The data obtained is given in **Table 1** below.

Phenotype	Genotype	Number of plants
Flowers with long spikes	RR	200
Flowers with short spikes	Rr	347
Flowers without spikes	rr	153

Table 1

i. Calculate the frequency for allele 'R' and 'r'. (2 marks)
ii. Calculate the frequency for RR and Rr. (1 mark)

Continued...

b. Wheat, *Triticum aestivum*, owes its origin to hybridization involving three different, but related, species of grass, **A**, **B** and **C**. Each of these species had seven pairs of chromosomes (2n = 14). The hybridization process is shown in **Figure 2**.

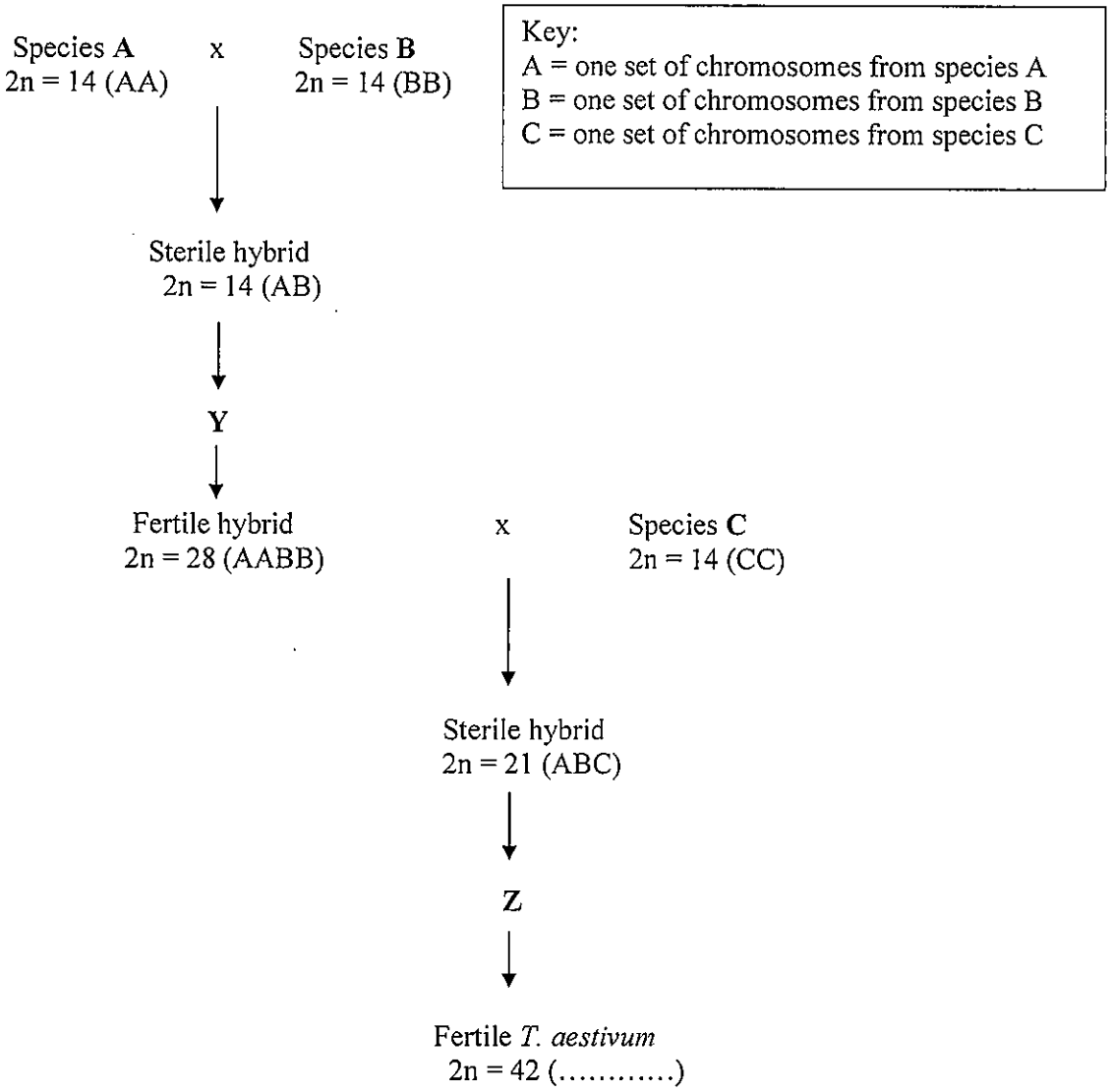


Figure 2

i. Using the symbols in the key, complete **Figure 2** by writing in the chromosome sets of *T. aestivum*. (½ mark)

ii. At the points labeled **Y** and **Z** in the hybridization process, a fertile hybrid was produced from a sterile hybrid. What occurred at the point labeled **Y** in **Figure 2**? (1½ marks)

iii. Explain why the hybrid (AB) is sterile. (1 mark)

Continued...

c. **Figure 3** shows the chromosome 21 abnormality during gamete formation in meiosis.
   i. How many chromosomes are found in the somatic cells of a person with Down syndrome? (½ mark)
   ii. Briefly explain how Down syndrome can occur in humans. (1½ mark)
   iii. Give two characteristics of a person who has Down syndrome. (1 mark)

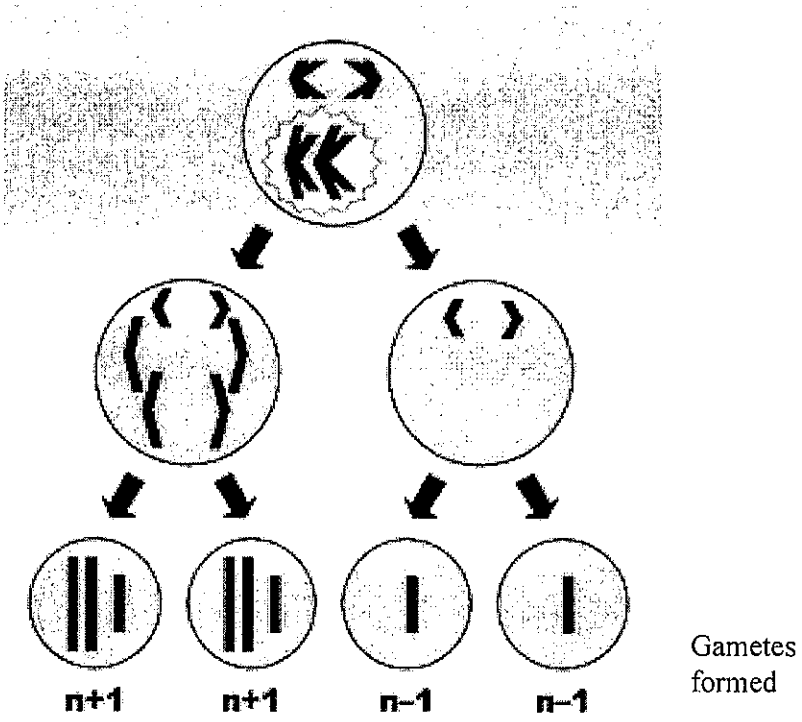


Figure 3

d. The Hardy-Weinberg Law states that in a population, the frequency of dominant and recessive alleles remains constant from generation to generation provided that certain conditions exist. Briefly describe any two of these conditions. (1 mark)

Continued...

Question 3 (10 marks)

a. **Figure 4** shows part of the stages in the synthesis of human insulin (humulin) using DNA technology.

i. What is the enzyme used in stages **A**, **B** and **C**? (1½ marks)

ii. Why is the cDNA gene made often shorter than the natural form of the gene? (½ mark)

iii. What is the name given to the combined DNA? (½ mark)

iv. Give two reasons why humulin is considered better than animal insulin. (1 mark)

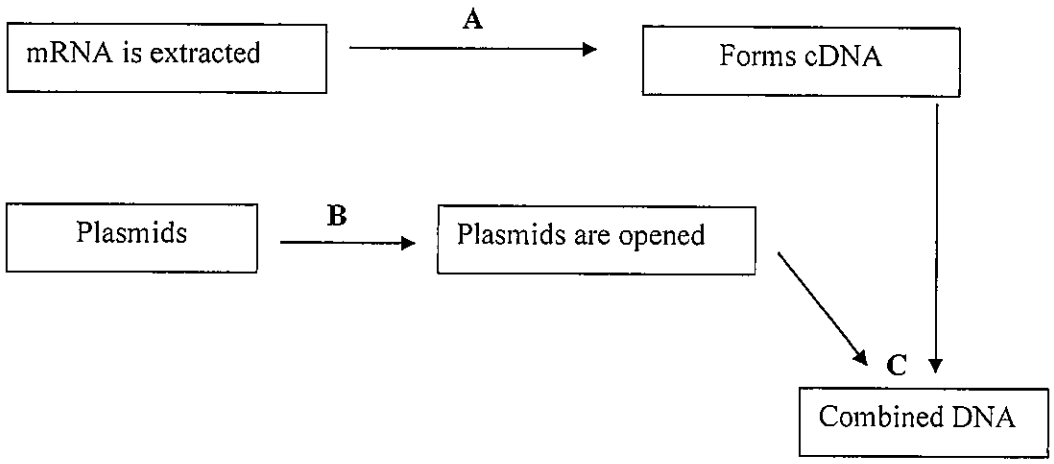


Figure 4

b. The polymerase chain reaction (PCR) can be used to obtain many copies of a particular gene.

i. Why is DNA heated to 95 °C in the PCR? (½ mark)

ii. Explain the *annealing* process in PCR. (1 mark)

iii. Starting with a single molecule of DNA, the polymerase chain reaction was allowed to go through five complete cycles. How many molecules of DNA would be produced after five complete cycles? (½ mark)

Continued...

c. A DNA molecule was split into fragments using the restriction enzyme *Eco*R1. Gel electrophoresis was then used to separate these fragments of DNA. **Figure 5** shows the result of running the gel electrophoresis.

i. Briefly explain how gel electrophoresis works. (½ mark)

ii. How many times does the enzyme *Eco*R1 cut this section of DNA? (½ mark)

iii. Define the term "*base pair*" in DNA. (1 mark)

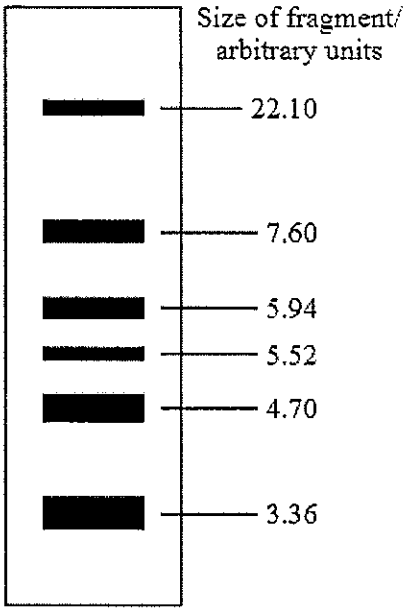


Figure 5

Continued...

d. A dead body was found but the identity of the victim is still unknown. The forensic team decided to use DNA fingerprinting to identify the victim. A couple, who claimed that their son had been missing, wanted to know whether it was their son's dead body. **Figure 6** shows the result of the DNA fingerprinting which included the victim's as well as the couple's DNA.

i. Is the victim their son? Explain your answer. (1½ marks)

ii. State two other uses of DNA fingerprinting. (1 mark)

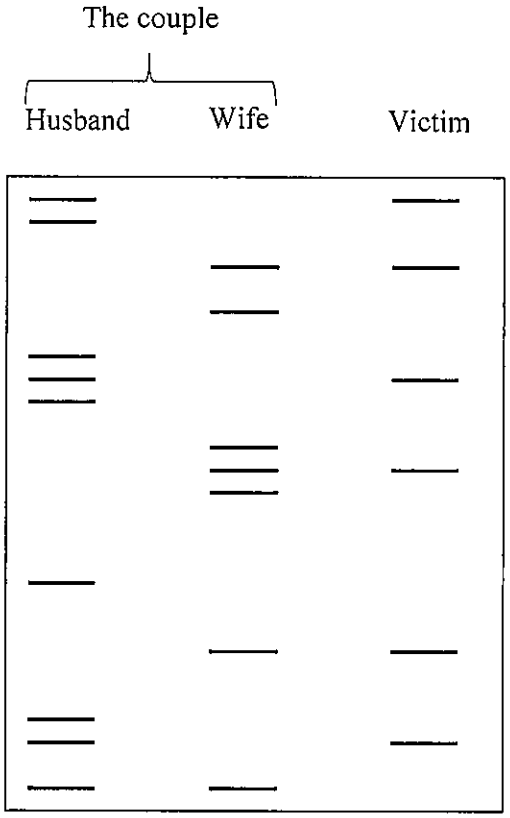


Figure 6

Question 4 (10 marks)

a. **Figure 7** shows how DNA is involved in protein synthesis.
   i. Name process **A** and process **B**. (1 mark)
   ii. In eukaryotic cells, RNA transcripts are processed in the nucleus before moving to the cytoplasm for translation. Explain the processes that take place in the nucleus during this phase. (2½ marks)
   iii. Explain how mRNA is involved in protein synthesis. (2½ marks)

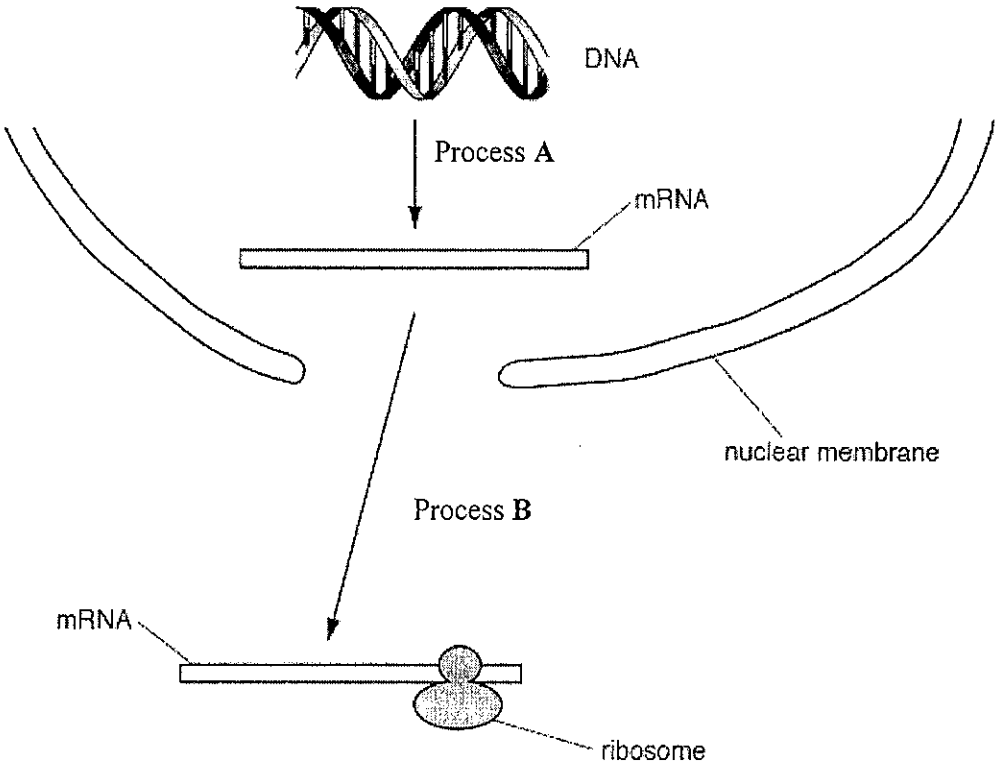


Figure 7

b. Explain the following terms.
   i. Proto-oncogene
   ii. Tumor-suppressor genes

(1 mark)

Continued...

c. **Figure 8** shows the *lac* operon structure in *E.coli.*
   i. Name structures **P** and **Q**. (1 mark)
   ii. What is the function of structure S? (1 mark)
   iii. What will happen if lactose is absent in the medium? (1 mark)

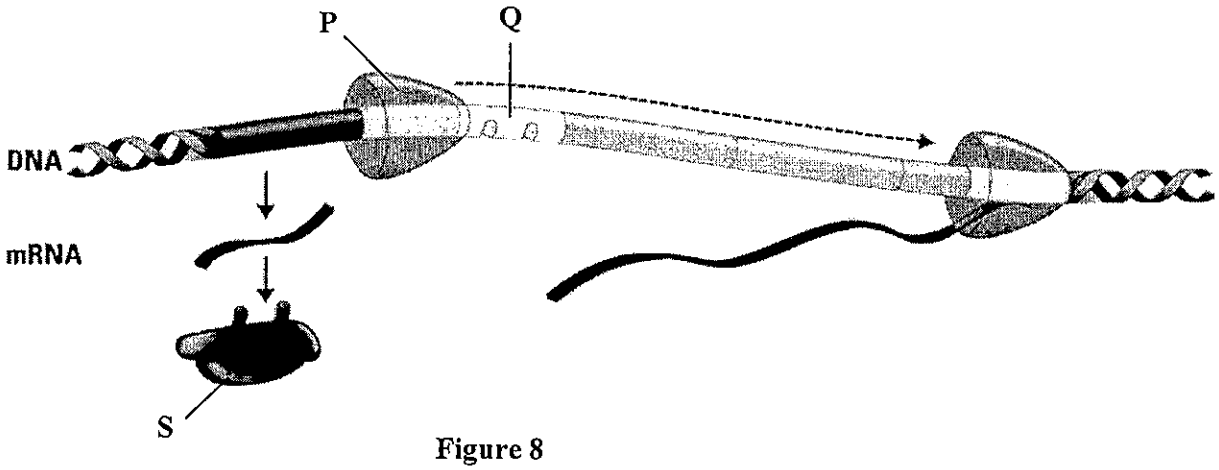


Figure 8

Question 5 (10 marks)

a. Successful pollination results in fertilization. Describe the events that occur from the time pollen grains leave the anther of a flower until fertilization takes place. (2 marks)

b. Flies need to undergo metamorphosis during their life cycle.
   i. What is meant by the term metamorphosis? (1 mark)
   ii. Briefly explain the process of *complete metamorphosis* in flies. (1½ marks)

Continued...

c. **Figure 9** shows the development of a zygote.

i. Explain how structures **R** and **S** are different from each other. (1 mark)

ii. Trophoblast villi will develop into a temporary organ that plays a crucial role during pregnancy in keeping the fetus alive and well. Explain three functions of this organ. (1½ marks)

iii. Name the structure labelled **T** and state its function during pregnancy. (1 mark)

iv. Where does the implantation of structure **X** occur? (½ mark)

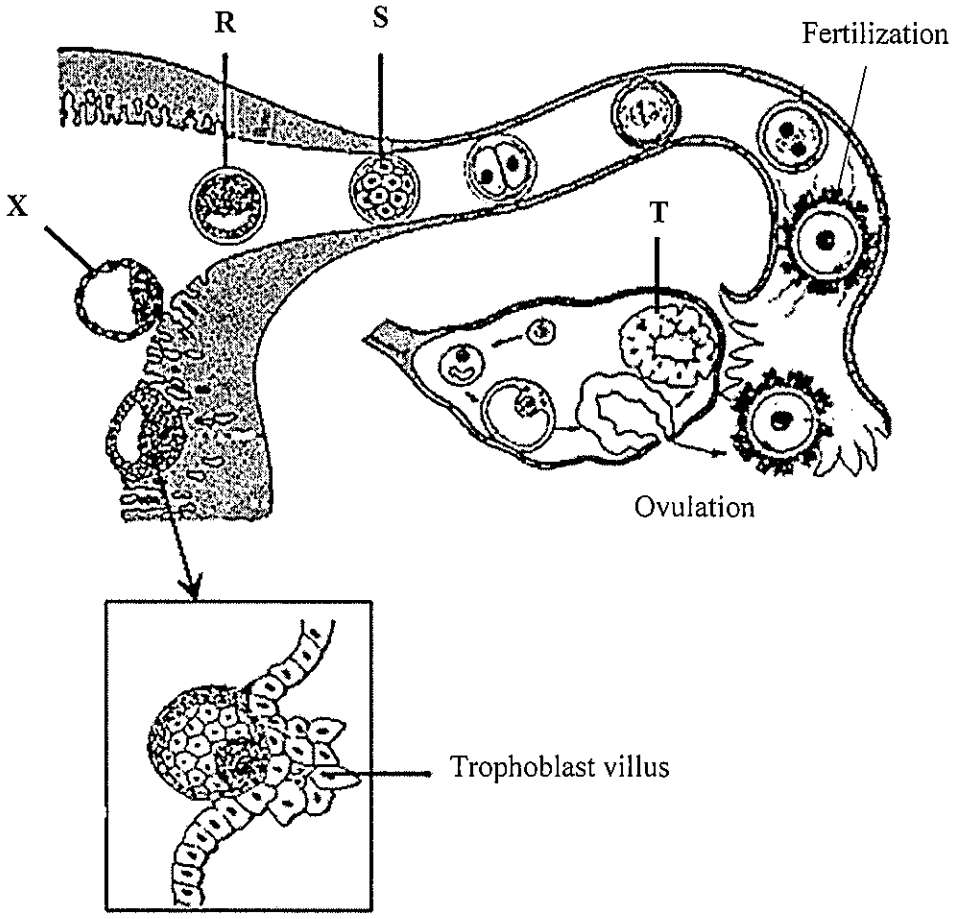


Figure 9

Continued...

d. **Figure 10** shows changes in the population of yeast in the fermentation tank.
   i. Name the phase labelled **X**. (½ mark)
   ii. Suggest two reasons why the population stops growing in the decelerating phase. (1 mark)

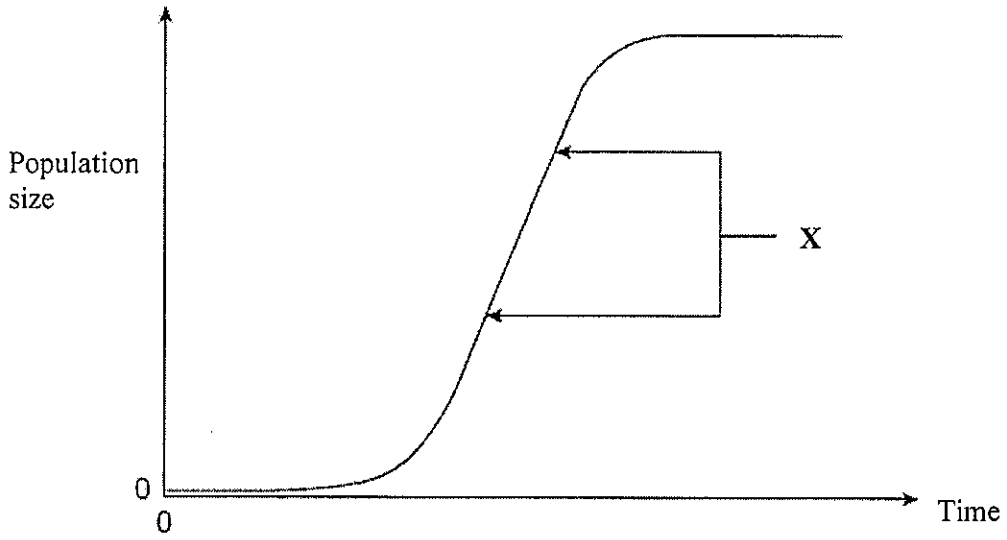


Figure 10

End of Paper